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Standard Methods of Test for

RESISTANCE OF PLASTICS TO ACCELERATED SERVICE CONDITIONS[1]

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1. Scope

1.1 These methods cover the determination of the weight and shape changes occurring in plastics under various conditions of use, not where exposure to direct sunlight, weathering, corrosive atmospheres, or heat alone is involved, but where changes in atmospheric temperature and humidity are encountered. This embraces the interior of buildings, and the interior of transport facilities such as motor vehicles, airplane cargo spaces or wing interiors, holds of ships, and railroad cars. Procedures are provided for exposing plastics to combinations of extreme humidity and temperature that will accelerate the changes taking place in the materials kept in sheltered spaces but subject to humidity and temperature variation. (See Explanatory Note).

1.2 Seven test procedures are provided which prescribe conditions for different types of exposure. Six of the procedures cover exposures at graduated levels of temperature and extremes of humidity; the seventh prescribes conditions involving alternate exposure to high and low temperatures. Insofar as weight and shape changes, embraced under the general term of dimensional stability, are concerned, these procedures provide a method of test. Further use of any of the conditions set up in the procedures is suggested, such as conditioning schedules prior to physical testing of the plastic either to test it at the particular condition involved, or to study changes resulting from exposure to that condition.

NOTE 1—The values stated in U.S. customary units are to be regarded as the standard. The metric equivalents of U.S. customary units may be approximate.

2. Significance

2.1 The test conditions covered in these methods represent a start towards organizing a group of test procedures for determining the effects of specified changes of atmospheric temperature and humidity upon plastic articles. These procedures have been used for testing both thermosetting and thermoplastic materials.

NOTE 2—The test procedures covered in these methods have been drawn from various tests used in branches of the plastics industry, and by government agencies in procurement of materials.

2.2 While several of the testing temperatures are not used in other ASTM methods, they have a background of several years experience in portions of the plastics industry. Especially in Procedures D and E (Sections 11 and 12) the accelerating effect of temperature in prompting changes caused by a rise in humidity leads to temperatures that are well above those encountered in normal service, and they are used simply to accelerate change.

2.3 Procedure A (Section 8) has been found to develop warping, weight change, and exudation in plastic parts. Procedure B (Section 9) is designed to reveal poorly cured plastics by developing cracks in them. Procedures C and D are more severe measures of the same tendencies developed in Procedure A; the conditions of Procedure D will produce noticeable chemical decomposition in many plastics. Procedure E (Section 12) is especially valuable in testing the behavior of plastic parts with metallic inserts and laminates, for cracking on exposure to temperature change. Procedures F and G are modifications of Procedure A, applying to impact-resistant and low heat-distortion temperature types of thermoplastics, respectively.

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3. Apparatus

3.1 *Balance*—A balance capable of weighing accurately to 0.05 percent a test specimen weighing 100 g or less, and to 0.1 percent a test specimen weighing over 100 g.

3.2 *Oven*—A circulating-air oven capable of maintaining the required temperature of test within ±1 C (1.8 F).

3.3 *Containers*—Noncorroding containers with a shelf to support the test specimen above the solution used for maintaining the required humidity. The container shall be tightly sealed except for a small capillary which permits release of vapor pressure that might otherwise lift the top off the container. Each test specimen shall be tested preferably in a separate container.

3.4 *Desiccator*—A clean, dry, uncharged desiccator or equivalent closed container in which to bring test specimens to room temperature.

3.5 *Absorbent Cloth*—Clean, nonlinting absorbent cloth for use in wiping exudation or condensed moisture from test specimens.

3.6 *Micrometer*—A micrometer capable of measuring dimensions of test specimens to 0.025 mm (0.001 in.).

3.7 *Cold Box*—A cold box capable of maintaining the required temperature of test within ±3 C (5.4 F).

Test Specimens

4.1 The general term plastics is used to describe the samples tested, since it is the intent of these methods to provide testing procedures which apply with equal validity to finished articles comprising plastics components together with other materials, to plastics parts, to plastics articles, to test specimens molded from plastics, and, if shape and nature of the material permit, to sheets, rods, tubes, or other plastic shapes furnished in a finally processed form. The shape, size, and process of forming greatly influence the behavior of plastic objects, hence a standard size test specimen is not prescribed in these methods, but the type of test specimen to be used shall be specified by the purchaser. Each test shall be made in duplicate.

5. Conditioning

5.1 *Conditioning*—Condition the test specimens at 23 ± 2 C (73.4 ± 3.6 F) and 50 ± 5 percent relative humidity for not less than 40 h prior to test in accordance with Procedure A of ASTM Methods D 618, Conditioning Plastics and Electrical Insulating Materials for Testing,[2] for those tests where conditioning is required. In cases of disagreement, the tolerances shall be 1 C (1.8 F) and ±2 percent relative humidity.

5.2 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of 23 ± 2 C (73.4 ± 3.6 F) and 50 ± 5 percent relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreement, the tolerances shall be 1 C (1.8 F) and ±2 percent relative humidity.

6. Measurements of Test Specimens

6.1 The following measurements shall be made on conditioned test specimens prior to testing, after reconditioning at the end of a test procedure, and at any intermediate stage as prescribed in the test procedures:

6.1.1 *Weight*—The weight within 0.05 percent if the specimen weighs 100 g or less, and within 0.1 percent if the specimen exceeds 100 g in weight.

6.1.2 *Dimensions*—The thickness to 0.025 mm (0.001 in.), the plane dimension in the direction of injection or transfer to 0.025 mm (0.001 in.), and the plane dimension across the direction of injection or transfer to 0.025 mm (0.001 in.).

6.1.3 *Dimensions of Compression Molded Specimen*—The thickness to 0.025 mm (0.001 in.), and the perpendicular dimensions in the plane at right angles to the direction of molding to 0.025 mm (0.001 in.).

6.2 Specimens shall be brought to room temperature in the uncharged desiccator, which will require 10 to 30 min. Then the specimen shall be weighed in less than 10 min after exposure to room conditions. The dimensions shall be measured immediately after weighing the specimen.

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[2] *Annual Book of ASTM Standards*, Part 27.

6.3 At the discretion of the purchaser, requirements for weights and measurements at intermediate stages given in the procedures may be omitted.

7. Visual Examination

7.1 Noticeable qualitative changes in surfaces, outline, and general appearance of the test specimen shall be recorded after each stage of the testing procedure. These changes include color, surface irregularities, odor, and splits, in accordance with ASTM Nomenclature D 883, Relating to Plastics.[2] Changes shall also be noted as they occur, especially those which alter the shape so that intended dimensions are no longer significant.

8. Procedure A

8.1 The test cycle for Procedure A shall be as follows:

24 h at 60 C (140 F) and 88 percent relative humidity, followed by
24 h at 60 C (140 F) in the oven.

8.2 Condition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

8.3 Expose the specimen for 24 h on the shelf of a container maintained at 60 ± 1 C (140 ± 1.8 F) in the oven, and containing a saturated solution of sodium sulfate to maintain a relative humidity of 85 to 89 percent.

8.4 Remove the specimen from the container, place it in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

8.5 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

8.6 Within 2 h after completion of the operation described in 8.3, expose the specimen for 24 h in the oven at 60 ± 1 C (140 ± 1.8 F).

8.7 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

8.8 Weigh the specimen, measure dimensions, and examine visually in accordance with Sections 6 and 7.

8.9 Recondition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

8.10 The specimen may be subjected to physical tests in accordance with Section 15.

9. Procedure B

9.1 The test cycle for Procedure B shall be as follows:

72 h at 60 C (140 F) in the oven.

9.2 Weigh and measure dimensions of the specimen in the as-received condition in accordance with Section 6.

9.3 Expose the specimen for 72 h in the oven at 60 ± 1 C (140 ± 1.8 F).

9.4 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

9.5 Weigh the specimen, measure dimensions, and examine visually in accordance with Sections 6 and 7.

10. Procedure C

10.1 The test cycle for Procedure C shall be as follows:

24 h at 70 C (158 F) and 70 to 75 percent relative humidity, followed by
24 h at 70 C (158 F) in the oven.

10.2 Condition the specimen, weigh, and measure its dimensions in accordance with Sections 5 and 6.

10.3 Expose the specimen for 24 h on the shelf of a container maintained at 70 ± 1 C (158 ± 1.8 F) in the oven, and containing a saturated solution of sodium chloride to maintain a relative humidity of 70 to 75 percent.

10.4 Remove the specimen from the container, place it in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

10.5 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

10.6 Within 2 h after the completion of the operation described in 10.3, expose the specimen for 24 h in the oven at 70 ± 1 C (158 ± 1.8 F).

10.7 Place the specimen in the uncharged desiccator and bring to room temperature in accordance with 6.2.

10.8 Weigh the specimen, measure dimensions, and examine visually in accordance with Sections 6 and 7.

10.9 Recondition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

10.10 The specimen may be subjected to physical tests in accordance with Section 15.

11. Procedure D

11.1 The test cycle for Procedure D shall be as follows:

24 h at 80 C (176 F) over water, followed by
24 h at 80 C (176 F) in the oven.

11.2 Condition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

11.3 Expose the specimen for 24 h on the shelf of a container maintained at 80 ± 1 C (176 ± 1.8 F) in the oven, and containing distilled water to maintain a humid atmosphere.

11.4 Remove the specimen from the container, place it in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

11.5 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

11.6 Within 2 h after the completion of the operation described in 11.3, expose the specimen for 24 h in the oven at 80 ± 1 C (176 ± 1.8 F).

11.7 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

11.8 Weigh the specimen, measure dimensions, and examine visually in accordance with Sections 6 and 7.

11.9 Recondition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

11.10 The specimen may be subjected to physical tests in accordance with Section 15.

12. Procedure E

12.1 The test cycle for Procedure E shall be as follows:

24 h at 80 C (176 F) and 70 to 75 percent relative humidity, followed by
24 h at −40 C (−40 F) or −57 C (−70.6 F) as specified.
24 h at 80 C (176 F) in the oven.
24 h at −40 C (−40 F) or −57 C(−70.6 F), as specified.

12.2 Condition the specimen, weigh, and measure its dimensions in accordance with Sections 5 and 6.

12.3 Expose the specimen for 24 h on the shelf of a container maintained at 80 ± 1 C (176 ± 1.8 F) in the oven and containing a saturated solution of sodium chloride.

12.4 Remove the specimen from the container, and wipe excess moisture from it with the absorbent cloth.

12.5 Within 30 min after the completion of the operation described in 12.3, expose the specimen for 24 h in a cold box maintained at −40 ± 2 C (−40 ± 3.6 F) or −57 ± 2 C (−70.6 ± 3.6 F), as specified.

12.6 Place the specimen in the uncharged desiccator and bring to room temperature in accordance with 12.2.

12.7 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

12.8 Within 2 h of the completion of the operation described in 12.5, expose the specimen for 24 h in the oven at 80 ± 1 C (176 ± 1.8 F).

12.9 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

12.10 Within 30 min after the completion of the operation described in 12.6, expose the specimen for 24 h in the cold box at −40 ± 2 C (−40 ± 3.6 F) or −57 ± 2 C (−70.6 ± 3.6 F), as specified.

12.11 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

12.12 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

12.13 Recondition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

12.14 The specimen may be subjected to physical tests in accordance with Section 15.

13. Procedure F

13.1 The test cycle for Procedure F shall be as follows:

24 h at 38 C (100.4 F) and 100 percent relative humidity, followed by
24 h at 60 C (140 F) in an oven.

13.2 Condition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

13.3 Expose the specimen for 24 h in a container maintained at 38 ± 1 C (100.4 ± 1.8 F) and 100 percent relative humidity (obtained by using distilled water as the humidifying medium).

13.4 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

13.5 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

13.6 Within 2 h after the completion of the operations described in 13.3 and 13.4, expose the specimen for 24 h in the circulating air oven at 60 C (140 F).

13.7 Place the specimen in the uncharged desiccator and bring to room temperature in accordance with 6.2.

13.8 Weigh the specimen, measure dimensions, and examine visually in accordance with Sections 6 and 7.

13.9 Recondition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

13.10 The specimen may be subjected to physical tests in accordance with Section 15.

14. Procedure G

14.1 The test cycle for Procedure G shall be as follows:

24 h at 49 C (120.2 F) and 100 percent relative humidity, followed by
24 h at 49 C (120.2 F) in an oven.

14.2 Condition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

14.3 Expose the specimen for 24 h in a container maintained at 49 ± 1 C (120.2 ± 1.8 F) and 100 percent relative humidity (obtained by using distilled water as the humidifying medium).

14.4 Place the specimen in the uncharged desiccator, and bring to room temperature in accordance with 6.2.

14.5 Wipe the specimen with the absorbent cloth, then weigh, measure dimensions, and examine visually in accordance with Sections 6 and 7.

14.6 Within 2 h after the completion of the operations described in 14.3 and 14.4, expose the specimen for 24 h in the circulating air oven at 49 C (120.2 F).

14.7 Place the specimen in the uncharged desiccator and bring to room temperature in accordance with 6.2.

14.8 Weight the specimen, measure dimensions, and examine visually in accordance with Sections 6 and 7.

14.9 Recondition the specimen, weigh, and measure dimensions in accordance with Sections 5 and 6.

14.10 The specimen may be subjected to physical tests in accordance with Section 15.

15. Physical Tests

15.1 On appropriate test specimens, provided that prohibitive changes in dimension, structure, or shape have not taken place, physical tests, such as impact resistance and flexural strength may be conducted either at one of the test conditions, or after the final conditioning, for comparison with similar tests on specimens which have not been exposed to the conditions prescribed by these methods.

16. Report

16.1 The report shall include the following:

16.1.1 Description of test specimens, including material, shape, method of molding, and where obtained,

16.1.2 Test procedures used, and the number of cycles of each,

16.1.3 Average values of percentage changes in weight and dimensions found after (*1*) each stage of the testing procedure, and (*2*) reconditioning, when the entire cycle is finished. Notation shall be made whether all measurements prescribed in 6.1 were taken, or whether the simplified procedure of 6.3 was used, and

16.1.4 Description of qualitative changes in appearance that may have taken place during each stage of the test procedure.

EXPLANATORY NOTE

NOTE—To simulate the behavior of plastics subject to repeated exposure to heat and humidity, test procedures involving the use of repeated cycles of dry heat and humid heat may be selected from the single cycle test procedures described in these methods. In making such cycle tests, the initial conditioning shall be given followed by exposure to the test as stated. Subsequent test procedures shall be applied without reconditioning the specimen at the end of each unit of the cycle. For instance, in carrying out a three-cycle exposure to Procedure A, the first cycle shall be carried out in accordance with 8.1 to 8.8, the second cycle in accordance with 8.3 to 8.8, and the third cycle in accordance with 8.3 to 8.10. The reconditioning shall be always carried out at the end of the test cycle unless sample failure makes this step appear trivial. In reporting such tests, mention should be made of the various stages selected for the cycle, and the number of cycles to which the specimen is subjected.